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Advanced Modelling of the Interplay between Public Governance and Digital Transformation: New Empirical Evidence from Structural Equation Modelling and Gaussian and Mixed-Markov Graphical Models

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Abstract: The research conducted in this paper aims to appraise the interlinkages between public governance and digital transformation at the level of the European Union. We employ two advanced approaches to modelling longitudinal data compiled at the level of the EU-27 Member States during the 2010–2021 period, namely, structural equation modelling and Gaussian and Mixed-Markov graphical models. The main results indicate positive impacts on government effectiveness arise from the human capital involved in complex activities that engage the use of digital services, e-government users, and integration of digital technologies, and the effect of demands and supplies of digital public services using open data. This further supports the government's capabilities in enforcing regulations and policies to control corruption and sustain the achievement of digital skills, at least at a basic level, by the entire society. Moreover, good perceptions and a higher degree of confidence in the rules of law have a positive influence on the need for connectivity of digital services, especially the supply side of fixed and mobile broadband. Lastly, a relevant impact of regulatory quality is identified in the digital connectivity of broadband infrastructure, which is enclosed by the public governance representative indicators under the influence of a stronger integration of digitalisation.

Keywords: public governance; digital transformation; econometric modelling; European Union countries

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1. Introduction

The World Bank introduced the concept of "governance" as the manner through which governments succeed in managing their political authority in the efficient administration of resources to support economic and social development while also achieving its actions within the society [1]. Furthermore, "good governance" is considered an expression of the democratic capacities of institutions, and illustrates a contemporary management concept approach that has recently received an increased emphasis regarding public sector effectiveness and efficiency; it also includes a significant application in public sector organisations and various effects in different organisational settings [2].

Consequently, after the COVID-19 pandemic and other unpredictable circumstances, the need to implement and adapt to fast digital transformations, along with radical solutions, has led to considering "good governance" as a complex condition for governments and public institutions in offering and improving services in an integrative manner that can

satisfy the stakeholders and fulfil objectives that can benefit the whole society, by constantly defining strategic policies, re-examining past policies, and constantly adopting innovative techniques and methods [3]. Moreover, the primary forms and characteristics generally manifested refer to openness, efficiency, responsiveness, transparency, active participation, respect for the rule of law, equality, and mutual agreement [4].

Altogether, depending on the programs and activity priorities on which they are operating, several international institutions actively discuss and promote the concept of good governance within the worldwide community [5–8]. Similarly, the digital transformation of public governance also leads to worldwide adoption and integration difficulties with a high level of significance, taking into account the multiple effects and different impacts that can be produced throughout the entire society. Nevertheless, digital technologies depict an essential element of digital transformation that comprises all the radical and profound changes from the level of society [9,10]. The digital transformation of public governance can be considered a multi-beneficial process that can offer institutions the opportunity to innovate through digital technologies by creating and sustaining plans, strategies, and actions that allow embracing the implications and benefits of digital technology [11]. Digital technology needs data privacy, user protection, and robust cyber security provisions combined with a regulatory framework that fosters innovation and spurs public and private sector performance and growth.

The European Commission affirms the link between public governance and digital transformation through Europe's Digital Decade [12], which defines a paradigm that sustains the digital transformation of public services. Furthermore, the digital transformation of public governance approaches at the European Union Member States (EU-27 MSs) level has been debated previously within the existing literature but, as far as we know, their integrative impact has yet to be discussed.

In this currently complex framework, the present research aims to assess in a new advanced modelling approach the interlinkages between public governance (captured by World Governance Indicators—WGIs) and digital transformation (namely, the Digital Economy and Society Index (DESI) dimensions and subdimensions, and broadband-specific indicators), considering the EU-27 Member States, for the period between 2010–2021. We specifically target answering the following research question: *is there a notable relationship between public governance and digital transformation?*

To achieve this aim, the methodological endeavour applied consisted of two advanced econometric procedures that capture an integrative measurement approach (direct, indirect, and total) of the interplay between public governance and digital transformation through structural equation modelling (SEM) and Gaussian and Mixed-Markov graphical models (GGMs, MGMs, respectively).

The subject of digital transformation offers new research directions, and researchers are focusing on different aspects of the process, such as effects, sectors, and methods of measuring the implementation of digitalisation [13,14]. The scientific literature reveals that, regarding the adoption of digitalisation, the authorities were limited to the options that the pandemic period offered them because the emphasis was on rapid implementation in response to current needs, and was not based on its efficiency or results expected under optimal implementation conditions [15]. In addition, other studies have shown that external factors determine the digital transformation of public governance, instead of the intrinsic desire of governments to automate internal processes or to increase the range of digital products offered to citizens [16]. The choice of our research topic was also motivated by the fact that the governmental digital transformation (DGT) process was accelerated in the context of the COVID-19 crisis, its intensity being different from country to country, and the implications generated regarding public governance and citizens were less addressed. Our study outlines an overview of the relationship between public governance and digital transformation by analysing a new dataset that extends over a recent period of time, which also includes the pandemic period, but is not limited to this.

Considering the ongoing unexpected circumstances (pandemic crisis with COVID-19, global wars, climate change), our results complement the specialised literature in the field with the formation of useful guidelines, recommendations, or suggestions that may be valuable for decision makers, different national strategies, or common international guidelines regarding the digital transformation of public governance in EU-27 Member States (specific ways through which digital transformation enables new ways of public governance functioning). Additionally, to strengthen the knowledge in the scientific field, this research examines important issues and contributes with results that can sustain further research on the discussed topic.

Our paper offers new insights that can provide the grounding to identify the essential conclusions, policy recommendations, mechanisms, and strategies that need to be designed, adopted, and implemented within all the European Union Member States (EU-27 MS) to support the integration of digital technologies in public sector governance, with multiple benefits for society as a whole, focusing on digital transformation, for good public governance, as well as for the well-being of the community.

One of the purposes of this paper is to present a complex empirical analysis that is performed to identify and highlight the impact and effects of digital transformation and broadband infrastructure on public governance in the EU-27 Member States. In addition, this paper investigates the effects of digital transformation and broadband infrastructure on public governance. It also investigates future answers to the continuous improvement in the public sector from the perspective of covering existing gaps and increasing responses to various shocks that occurred over time, which underlined the need to integrate digital tools and broadband infrastructure elements. Moreover, this study also aims to identify the multiple effects of digital transformation on public governance and underline how to provide citizens with high-quality digital services, characterised by speed, easy access, and equity, in a framework of governance that can be characterised by an essential feature of openness towards efficient cooperation between the public sector and citizens. The digital transformation and broadband infrastructure are considered facilitators that can have a significant positive impact on aggregate levels of economic growth and revolutionise public governance at the level of EU Member States [17–19].

Accordingly, this paper highlights how digital transformation can contribute to fostering the quality of public governance through a performant broadband infrastructure by widening its accessibility, application, and equity, and how this can reinforce the knowledge of the integration of digital tools and broadband elements in public governance, which are often addressed in the new era of digital transformation of the public sector. In addition, in practical terms, our results provide indications about digital transformation of public governance initiatives that can support the plan for digitalisation that the European Union Member States must implement. Therefore, based on these facts and given the results obtained, our research contributes several components to the existing literature and brings new evidence on the perspective of integration of digital tools and high-quality broadband infrastructure in public governance. First, it can be argued that our research contributes to the existing literature and brings new insights regarding the interlinkages between digitalisation-specific indicators and broadband infrastructure representative variables in public governance coordination. Furthermore, most of the previous research studies are focused only on the digital transformation of public governance dimensions, with a narrow focus only in specific European countries, such as Italy [20], Germany [21], Sweden [22], Portugal [23], Denmark [24], or Greece [25], while fewer papers have focused on and analysed a panel comprising many countries from the EU-27, which is nuanced aspect of the novelty of our study. Secondly, our study contributes to the existing literature with a new empirical framework designed as part of an integrative and updated assessment of the effects generated by the digital transformation. This framework comprises DESI dimensions and subdimensions and some specific broadband variables in the public governance dimension represented by worldwide governance indicators and based on an empirical approach. In contrast, other studies from the existing literature have only focused on a qual-

itative assessment of the current state of knowledge in the field [26]. Third, the reliability of our findings is checked by applying two advanced econometric models, namely, structural equation modelling (SEM), in order to appraise overall interlinkages among considered variables; and Gaussian and Mixed-Markov graphical models, which allowed us to observe the intensity and configuration of the interlinkages between all considered variables for all the EU-27 countries.

Therefore, this research study entails a new in-depth perspective and enhances the existing body of literature with an integrative assessment of the interlinkages between public governance and digital transformation. This is achieved by applying two advanced econometric techniques to create accurate and robust results. This provides a clearer picture of the tailored specific strategies that the EU-27 states can adopt to rethink the digital transformation in public governance.

The structure of this research investigation is organised as follows: Section 2 reviews the relevant literature and presents the derivation of our hypotheses. The data and the methodology applied are introduced in Section 3. Section 4 reports the main findings and interprets the empirical outcomes with substantial discussions. Section 5 offers conclusive notes, followed by additional information in Appendix A, where the empirical results are detailed.

2. Literature Review

The subject of public governance and digital transformation has been addressed in several studies [27–30]. The analysis of the existing literature highlighted concepts such as "smart cities", "smart citizens", or "smart governance", and outlined the state of knowledge regarding the implications of digital transformation for public governance [31–33]. The studies selected in the systematic analysis are divided into studies that conceptually define the elements involved in the digitalisation process of public governance, and empirical studies that comprise analysis models used to identify the implications and effects of these elements. Sarker, Wu, and Hossin defined smart governance as a system comprising components that quickly respond to social changes generated by a complex environment, effectively using the available resources to make appropriate decisions and achieve social goals [31]. Smart governance at the local level can embrace the form of smart cities. Information and Communication Technologies are considered globally to be the basis of a smart city. Nonetheless, the essential component of ICT is the processing of data from various sources to ensure the city's sustainability via its management and development [32]. Public governance represents the sum of processes, decisions, and implementations carried out by specific actors, where the main actor is the government. Digital transformation refers to the entire governance process, from interacting with citizens to implementing public policies or fulfilling socioeconomic objectives [34]. In addition, the digital transformation of public governance has led to the formation and development of the concept of "good governance". Good governance suggests the characteristics that governance must achieve in the context of digitalisation, and the essential features of good governance refer to respect for the rule of law, participation, efficiency, and equity [35].

Caragliu, Del Bo, and Nijkamp emphasise that the mere adoption of Information and Communication Technologies fails to convert a city into a smart city. Many research studies [32,36] affirm that a smart city must have a set of characteristics that include the following: (i) the efficient use of technological infrastructure in the political, economic, social, and development processes; (ii) the stimulation of business development; (iii) the reduction in disparities between social classes regarding the use of technology and public services; (iv) the emphasis on the role of creativity and high technology for long-term development; (v) the development of the role of social relations in urban development; and (vi) the increase in sustainability. These elements are part of a smart city and protect natural resources [36]. Each institution plays a crucial role in smart city development, and their level of involvement leads to different results. The more essential the roles played by local government in implementing projects, the more emphasis will be placed on these

institutions' political goals or interests. The national government must fulfil its role as a regulator and mediator to ensure the standardisation of development policies [37]. The dimensions of the previously described terms reflect the potential and purpose that digital technology must have in the governance process [38].

Thus far, a number of research studies have included specific theoretical frameworks that address a series of conceptual terms regarding both public governance and digital transformation, by considering them under different meanings with multilevel measurements [39–41].

In the existing literature that addresses this subject, a series of specific terms can be identified, as detailed and explained in Table 1.

Table 1. Terms and expressions that form the theoretical framework specific to the process of digital transformation of public governance.

The Conceptual Framework for Digital Transformation		
Expression	**Reference**	**Definition**
Smart society	[42]	"an advanced form of society following agricultural society, industrial society, and information society, with digital data processing system as its main carrier"
Smart city	[43,44]	"a smart city is a city which invests in ICT enhanced governance and participatory processes to define appropriate public service and transportation investments, that can ensure sustainable socioeconomic development, enhanced quality-of-life and intelligent management of natural resources"
Smart citizen	[45]	"smart citizen produces and uses information through systems efficiently and sustainably in order to form smart cities"
Smartness framework	[38]	"a managerial and service delivery point of view of government initiatives with four dimensions: efficiency, effectiveness, transparency, and collaboration"
Digital economy	[46,47]	"a system of economic, social and cultural relations based on the use of digital information and communication technologies"
Digital infrastructure	[48]	"the totality of cable, fibre and telecommunications networks, data centres and front-end devices that can be manipulated and designed to achieve the desired strategic results"
The Conceptual Framework for Public Governance		
Expression	**Reference**	**Definition**
Good governance	[49]	"the process whereby public institutions conduct public affairs, manage public resources and guarantee the realisation of human rights in a manner essentially free of abuse and corruption, and with due regard for the rule of law"
Public governance	[44]	"a commitment to a mode of political and administrative steering that seek to address societal problems by more or less systematically designed and regulated interaction between public authorities and a wide array of private actors"
Public governance digitalisation	[34]	"can be defined as the process and outcome of digital transformation: the transformation of the "analogue" version of governance into "digital" governance"
E-government	[50]	"e-government is the process of changing the public sector through digitalisation and new information management techniques, a process whose ultimate goal is to streamline public administration and increase the degree of citizen participation in the administrative process"

Source: Authors' compilation.

Concluding the previously mentioned aspects [27–32,36–38], we must admit that the digital transformation of public governance branches out into many research fields and can have a twofold approach; first, by defining the specific terms and elements involved in the digital transformation process, and locating the digitalisation of public governance (institutional, local (rural and urban), regional, or national levels); second, by the area of implementation, measuring the degree of implementation/performance, measuring the effects on the socio-economic environment and well-being, addressing the risks involved, measuring the level of investigations, developing specific regulations, and ensuring information security.

Digital transformation has already been adopted and integrated all over the world, but the intensity of the process is different from one country to another. The maturity level of digitalisation is reflected in how requests are processed, from the reception of information to the provision of an answer, in which minimal human intervention and the integration of artificial intelligence indicate a high degree of maturation [13]. The process of digital transformation can be approached from the perspective of two strategies: the creation of added value through digital innovation (the government can influence the level of involvement of citizens in the activity of public service delivery); and the creation of added value through complexity (the government can create added value through information generated by data provided by public institutions or even by citizens) [51].

There is also a trend in measuring the digitalisation of public governance that approaches the subject from different perspectives. Similarly, the key points in the research trends regarding the measurement of digitalisation of public governance are based on the effects of government digitalisation; the quantitative and qualitative analysis of the implementation of digital technologies in public governance; and the analysis of the correlation between digital transformation, socio-economic development, and the increase in the quality of governance [13].

In most studies [27,46,52,53], the digitalisation of public governance has been associated with efficiency, innovation, or agility. Furthermore, in "World Development Report 2016", digital technologies and the government services delivery framework is based on inclusion, innovation, and voice [46]. In addition, Lobonț et al. [54] argued that the interactions between citizens and public authorities could be transformed by the adoption of e-government services, attesting that the level of e-government adoption is different among European Union countries, and has significant influences on and implications for large domains, including social, political, and economic areas.

Moreover, the results of other studies suggest that the growth in innovation is positively influenced by government efficiency and the rule of law; the correlation analysis between variables has been carried out on data obtained through the WGI (World Governance Indicators), Intramural R&D expenditure, The Global Innovation Index, and The Global Sustainability Competitiveness Index [52]. Accordingly, the increase in the performance of the government administration is based on the size of the digital technology infrastructure and the quality and geographical distribution of the technologies in the infrastructure [53].

The previously mentioned studies, as well as others, use the WGI in empirical analyses to measure digital transformation's effects. However, there are studies [34] that consider these indicators to be a measuring tool for analogue governance, while digital governance can be measured through the Digital Economy and Society Index (DESI), Online Service Index, E-Participation Index, Laws Relating to IT, ICT Use and Government Efficiency, or Importance of ICT to Government's Vision. The European eGovernment Benchmark report evaluates eGovernment services within the European Union and beyond. The digital government benchmark is analysed from a geographical point of view, emphasising the measures, programs, and platforms used in each of the 34 countries under analysis from the perspective of providing public services, transparency, and mobility [55]. Moreover, the measurement of the level of digitalisation can be approached in a new way in research, using Digital Economy and Society Index (DESI) subdimensions in regressions as explana-

tory variables of the dependent variable, the Digital Economy and Society Index (DESI total index). This enables identification of the particularities specific to each country in terms of digitalisation dimensions [56]. Noja et al. [57] employed the World Governance Indicators (WGIs) to identify the implications of public administration and measure public governance related to economic development. Dima et al. [58] underlined that the EU-27 Member States were confronted with significant discrepancies with respect to the quality of public governance. Although there are many opinions regarding measuring the digitalisation of public governance, we can affirm that the variables and indicators included in this research study are well grounded in theory the previous research from the existing scientific literature.

Considering the above arguments, the following research hypothesis (H1) is considered.

Hypothesis 1 (H1). *There are positive effects of digital transformation on public governance at the level of the European Union.*

In addition to the benefits to citizens and their well-being, digitalisation is also followed by a series of risks that can be reduced or eliminated over time and through the accumulation of experience. The risks associated with digitalisation include cybercrime, dependence on the technical infrastructure and information interconnection, reduction in demand for personnel, lack of synchronisation of systems (educational, administrative, economic, regulatory), and digital inequality based on differences in infrastructure and the skills needed to use technology [59]. However, the level of digital shortfall does not significantly influence the decision to use the digital interfaces to access certain digital public services [59]. The use of digital technologies negatively affects the well-being of citizens through the complexity of the technologies, causing a certain level of stress when they have to use a new technology [60].

However, we can discuss digital transformation only based on the existence of a technological infrastructure. To expand broadband connections, governments made investments or relied on economic operators in the field of telecommunications to develop this network, resulting in public–private partnerships [44]. The final report of the European Commission that analysed the evolution of broadband coverage of 31 countries in the European region identified a difference between the objectives of the projects "Universal Broadband Coverage with speeds at least 100 Mbps, upgradable to gigabit speed, by 2025" and "Gigabit connectivity for all by 2030", and the reality in the rural environment, noting constant differences between the average broadband coverage of countries and rural regions [61]. The European Commission is not the only institution concerned with broadband quality. Recent studies have analysed the influence of broadband speed on some processes carried out through applications to provide services such as tax collection. The results show that the use of connections with low download speed tends to lead to a decrease in the collection of tax revenues, while the complexity of the applications also blocks some processes [53]. Considering the importance of broadband quality and coverage at a country level for public governance and the delivery of digital public services, we can affirm the relevance of our study in analysing the linkages between digital transformation and public governance.

Along these lines, it can be hypothesised that:

Hypothesis 2 (H2). *There are strong interlinkages (both positive and negative) between digitalisation dimensions (including technological/broadband infrastructure) and public governance credentials.*

3. Materials and Methods

Reviewing the existing scientific literature, we can affirm that the novelty of our research compared to previous studies resides in the research framework designed and the approach by which the empirical analysis is carried out, and, more specifically, the methods used. To capture the interplay between public governance and digital transformation,

the World Governance Indicators (WGIs) and Digital Economy and Society Index (DESI) components were selected as variables, and structural equation modelling (SEM), along with Gaussian and Mixed-Markov graphical models, were applied as analysis methods. The Stata 17 software was used to process the structural equation modelling (SEM), and an integrative procedure aimed to appraise overall interlinkages among the considered variables (direct, indirect, and total). Further, based on the accurate SEM findings, we used RStudio 4.2.2. software to first design a Gaussian graphical model (GGM), and, second, a Mixed-Markov graphical model (MGM) that allowed us to observe the intensity and configuration of the interlinkages between all considered variables for the EU-27 countries.

3.1. Data and Indicators Employed in the Empirical Analysis

Based on the existing literature underpinnings, among the representative variables comprising our models, we included public governance components [62] and digitalisation-specific indicators [63], jointly with an integrated set of broadband indicators further employed in the empirical analysis.

The dataset comprises a sample that includes the 27-EU MSs analysed during the 2010–2021 period, with annual data frequency for all the variables. Consequently, in order to cope with the missing values in the analysed dataset for some variables, the mathematical extrapolation method was applied. This method was also implemented by other researchers, who aimed to predict a future pattern in the statistical data [64]. Furthermore, we applied linear extrapolation based on the previous data history to approximate the next data point since they are sampled periodically. The general formula used for extrapolation is presented in Equation (1) [64]:

$$y(x) = y_1 + \frac{x - x_1}{x_2 - x_1}(y_2 - y_1) \quad (1)$$

where: "x_1, y_1 and x_2, y_2 represents the two endpoints of a linear graph, and x represents the point which is to be extrapolated" [64].

The following selected indicators that are linked to our main general research objective were used as proxies for the variables included within the empirical models, clustered in two dimensions, respectively:

- Public sector governance: WGIs that are presented in standard normal units ranging from −2.5 to +2.5 [65]: government effectiveness (GE); regulatory quality (RG); the rule of law (RL); control of corruption (CCOR); voice and accountability (VA); and political stability and absence of violence/terrorism (PSAV);
- Digitalisation-specific indicators: connectivity (CMB); integration of digital technology (IDT); digital public services (DBS); human capital (HC); secure Internet servers (SECINT); fixed cellular subscriptions (MOBCELL); fixed broadband subscriptions (FBS); fixed telephone subscriptions (FTS); Internet user skills (INTS); advanced skills and development (ADVS); e-Government users (EGOV).

Based on the main findings from the literature, we found that Țăran et al. [56], Marino et al. [62], Noja et al. [57], and Dima et al. [63] were the authors that also focused on this topical subject, by using similar indicators and related methodological credentials.

Table 2 synthesises the description and meaning of the indicators included in the dataset.

Table 2. Description of dataset indicators.

Acronym	Description	Unit of Measure	Source
GE	Government effectiveness refers to "perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies." [66]	(−2.5, +2.5)	The World Bank
RQ	Regulatory quality "captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development." [66]	(−2.5, +2.5)	The World Bank
RL	The rule of law, which "captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence." [66]	(−2.5, +2.5)	The World Bank
CCOR	Control of corruption refers to the "perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests." [66]	(−2.5, +2.5)	The World Bank
VA	Voice and accountability "capture perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media."	(−2.5, +2.5)	The World Bank
PSAV	Political stability and absence of violence/terrorism "measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism." [66]	(−2.5, +2.5)	The World Bank
CMB	Connectivity—by mobile broadband, reflects the demand and the supply side of fixed and mobile broadband.	Weighted score (0 to 100)	European Commission, Digital Scoreboard
IDT	Integration of digital technology—by digital intensity, which covers the measures of business digitisation and e-commerce, which also have a series of representative indicators, including digital intensity.	Weighted score (0 to 100)	European Commission, Digital Scoreboard
DBS	Digital public services—by e-government, captures the demand and supply sides of digital public services and open data.	Weighted score (0 to 100)	European Commission, Digital Scoreboard
HC	Human capital—by Internet user skills, measured by the number and complexity of activities that involve the use of the Internet and digital devices.	Weighted score (0 to 100)	European Commission, Digital Scoreboard
SECINT	Secure Internet servers, "the number of distinct, publicly-trusted TLS/SSL certificates found in the Netcraft Secure Server Survey."	per 1 million people	The World Bank
MOBCELL	Mobile cellular subscriptions refer to "subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology."		The World Bank

Table 2. *Cont.*

Acronym	Description	Unit of Measure	Source
FBS	Fixed broadband subscriptions "refers to fixed subscriptions to high-speed access to the public Internet (a TCP/IP connection), at downstream speeds equal to, or greater than, 256 kbit/s."		The World Bank
FTS	Fixed telephone subscriptions "refers to the sum of an active number of analogue fixed telephone lines, voice-over-IP (VoIP) subscriptions, fixed wireless local loop (WLL) subscriptions, ISDN voice-channel equivalents and fixed public payphones."		The World Bank
INTS	Internet user skills, via at least basic digital skills, "individuals with 'basic' or 'above basic' digital skills in each of the following five dimensions: information, communication, problem-solving, software for content creation and safety."	Weighted score (0 to 100)	European Commission, Digital Scoreboard
ADVS	Advanced skills and development, by ICT specialists, "individuals with 'above basic' digital skills in each of the following five dimensions: information, communication, problem-solving, software for content creation and safety."	Weighted score (0 to 100)	European Commission, Digital Scoreboard
EGOV	e-Government Users, "individuals who used the Internet, in the last 12 months, for interaction with public authorities."	(percentage)	European Commission, Digital Scoreboard

Source: Authors' compilation.

The indicators were extracted from the World Bank for public sector governance dimensions and broadband indicators, Digital Agenda—European Commission, Digital Scoreboard for digitalisation, and all other variables for the period 2010—2021 (annual data). A significant effort was devoted to gathering relevant data from official sources and for longer time spans that are relevant in revealing the amplitude of the public governance and digitalisation processes. The lesser availability of data for certain indicators is a limitation often encountered in similar empirical research. Moreover, particular attention was paid to data analysis and processing methods; respectively, robustness checks and validation were applied to determine if the chosen variables properly suited the models that we developed, and were able to capture the effects and interlinkages between digital transformation, broadband infrastructure, and public governance.

The descriptive statistics of all indicators included within the econometric models are detailed in Table 3.

Furthermore, in our attempt to provide complementary views of how to present the differentials among the EU-27 MSs in terms of governance levels and digitalisation indicators, we selected a graphical representation that is based on a data mapping technique. Using this approach, we designed visually appealing maps that allowed us to separately observe the level of each selected indicator with data benchmarking between EU countries. In addition, the data mapping technique facilitates distinguishing the differences regarding one specific indicator by offering a general and comprehensive map of the European Union states. We designed the maps in Stata 17 software, where we engaged different features in order to reinforce the design of the generally created map, such as (i) different colours styles—to differentiate the countries of the European Union; (ii) different fonts—for better visualisation of the level of each indicator; (iii) locations—we established that the variables need to be represented at the level of EU-27 Member States; and (iv) legend—to identify the numerical values and the intensity/levels of each indicator.

Table 3. Descriptive statistics of the variables used in the empirical analysis, compiled at the level of the EU-27 MSs, for the 2010–2021 period.

Variables	N	Mean	Standard Deviation	Minimum	Maximum
GE	324	1.096	0.562	−0.22	2.24
RQ	324	1.162	0.455	0.15	2.05
RL	324	1.100	0.600	−0.13	2.13
CCOR	324	0.974	0.786	−0.5	2.41
VA	324	1.079	0.352	0.26	1.69
PSAV	324	0.731	0.355	−0.32	1.46
CMB	162	14.031	4.179	3.8	35.69
IDT	162	5.840	2.782	0.02	12.68
DBS	162	57.444	16.523	8.54	91.76
HC	133	25.330	5.988	10.46	38.31
SECINT	297	232,023.5	754,356.8	307	8,109,646
MOBCELL	297	2.002×10^7	2.67×10^7	455,579	1.10×10^8
FBS	297	5,149,675	7,700,996	124,889	3.60×10^7
FTS	297	6,698,929	1.14×10^7	211,849	5.29×10^7
INTS	162	27.668	6.151	13.12	39.75
ADVS	162	13.353	4.252	5.67	25.33
EGOV	134	63.767	18.697	12.09	94.08
N total	324				

Source: Authors' contribution in Stata 17.

For all six dimensions of governance indicators, Nordic countries such as Finland and Sweden registered the highest levels (Figure 1). Along with these two countries, the Netherlands, Denmark, and Austria recorded high levels of government effectiveness (1a). At the opposite extreme, the lowest values belonged to Bulgaria, Romania, and Poland, with the first two having negative values. Luxembourg, Denmark, and the Netherlands, together with Finland and Sweden (1b), led the ranking in terms of the recorded values of regulatory quality, and marked the implementation of policies that support economic development in general and the development of the public sector in particular. Romania, Greece, and Bulgaria were again at the bottom of the ranking with the lowest values and, implicitly, with the weakest levels of policy implementation. The perceived trust in the country's rule of law had the highest values in Finland, Denmark, and Austria, while in Bulgaria, Italy, and Greece, the level of trust and respect for society's rules and state institutions was found to be very low (1c). The very high values of control of corruption in the Nordic countries (Denmark, Finland, Sweden) indicate the existence of a public power that supports and is exercised for the benefit of citizens. On the other hand, in Bulgaria, Romania, and Hungary, which registered the lowest values of corruption control, the state also serves particular private interests (1d). Regarding voice and responsibility, freedom of expression, and active participation, Finland, Denmark, and Luxembourg led the ranking, and Bulgaria, Hungary, and Poland tended to place less emphasis on these elements when it comes to governance (1e). Finally, the last component of the World Governance Indicators, namely political stability and absence of violence/terrorism, ranked Luxembourg, Sweden, and Finland first in terms of safety values and predictability of public policies, whereas Greece, France, and Cyprus were at the bottom of the ranking (1f). There is a tendency among the Nordic countries to well regulate the role of public governance to support development, while the governments of central and south-eastern Europe tend to move away from what the dimensions of governance imply.

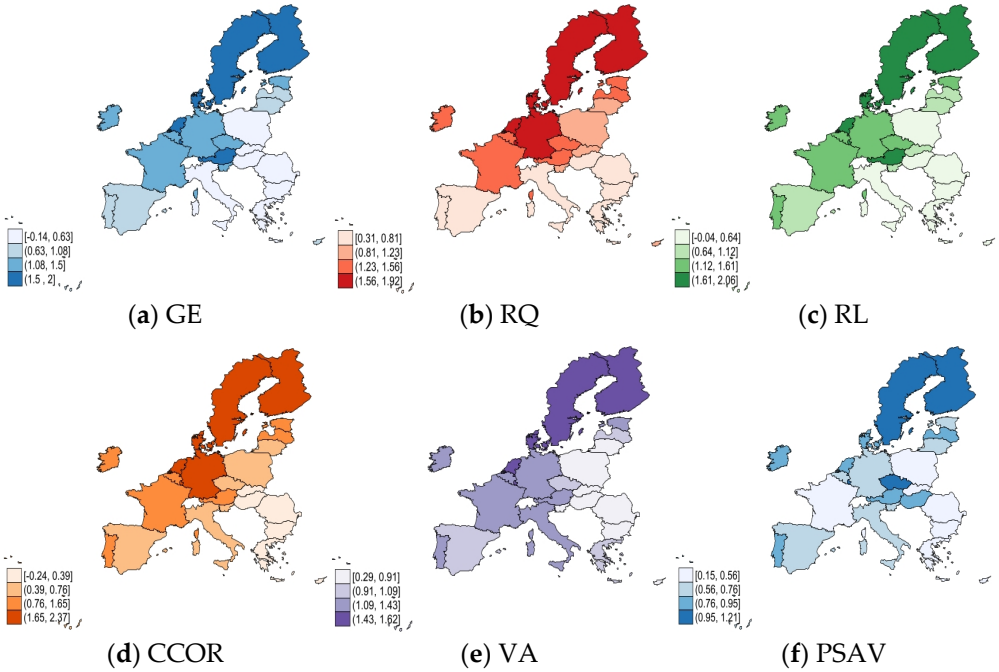

Figure 1. Governance indicators, EU-27, 2021. Source: Authors' research in Stata 17.

Regarding the Digital Economy and Society Index, the Nordic countries of the European Union also recorded the highest levels of digitalisation (Figure 2).

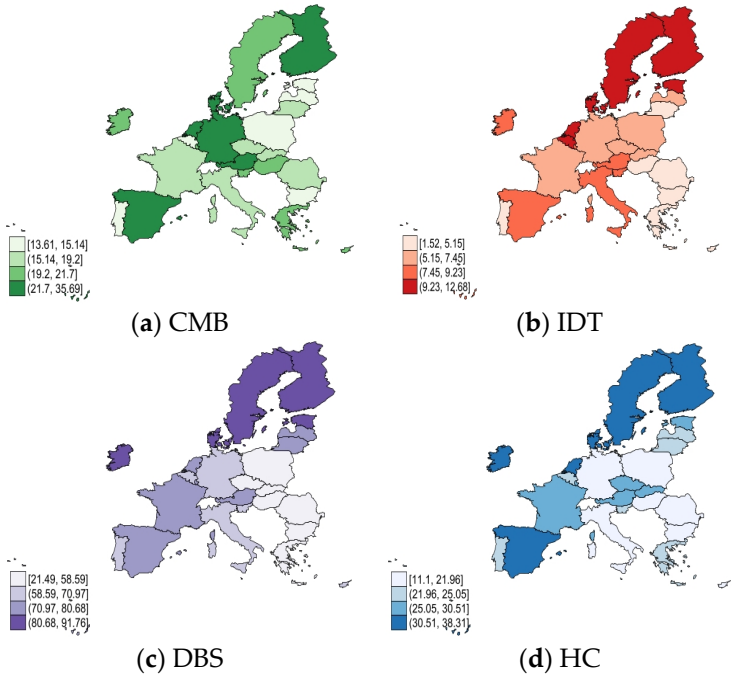

Figure 2. Digitalisation indicators, EU-27, 2021. Source: Authors' research in Stata 17.

The highest connectivity by mobile broadband was found in Denmark, the Netherlands and Austria, in addition to Germany, Finland, and Spain (Figure 2a). The highest level of integration of digital technology in the public and private sectors was registered in Denmark, Finland, and Sweden, and in the Netherlands, Belgium, and Estonia. At the opposite extreme, the lowest level of integration of digital technology was registered in Bulgaria, Romania, and Lithuania (Figure 2b). Most digital public services are offered by the governments of Estonia, Denmark, and Finland, and of Malta, Sweden, and Ireland

(Figure 2c). Regarding human capital, the Netherlands, Finland, and Ireland have the most people who have developed digital skills. Moreover, a high number of such people can be found in Denmark, Sweden, and Spain (Figure 2d).

3.2. Research Methodology

Looking into empirical methods applied for studying public governance and digitalisation [67–70], we relied on two modern advanced econometric methods specific to modelling longitudinal data, namely, structural equation modelling (SEM) and network analysis through Gaussian and Mixed-Markov graphical models (GGMs, MGMs, respectively).

Structural equation modelling (SEM) represents a measurement model that is employed to analyse the structural relationships among measured indicators and to provide robust estimates based on the sample extracted. Moreover, multiple and interconnected dependencies between the considered indicators can be assessed in a single analysis by employing a structural equation model (SEM), thus offering a consistent and comprehensive assessment of the relations considered [71].

Structural equation modelling (SEM) was employed in this research to test the first working hypothesis (H1) and to capture the accumulated effects of digital transformation on public governance. Hence, we configured an SEM that embeds all relevant digitalisation and public governance dimensions in line with our research's main purpose, as in Figure 3 below. The model was estimated through the maximum likelihood method (MLE).

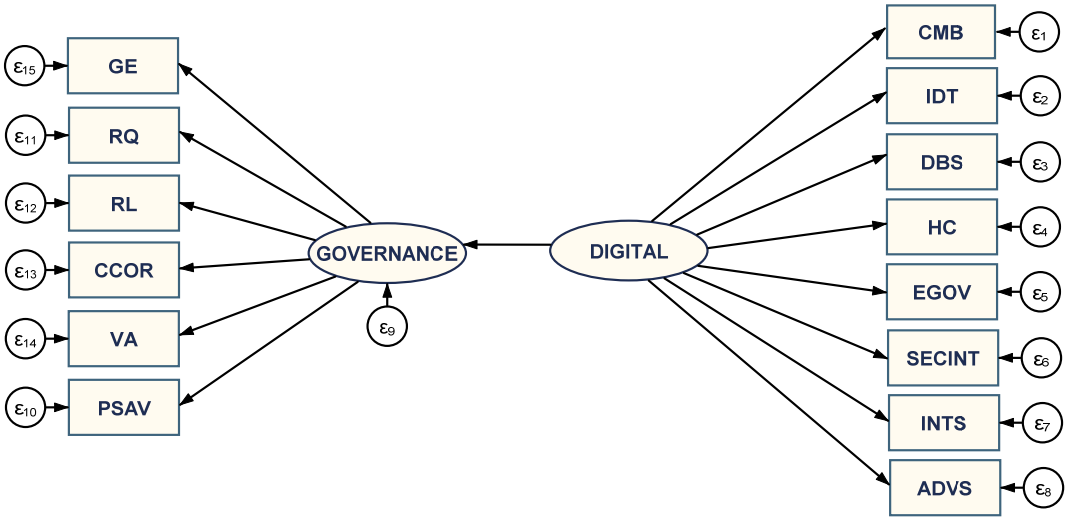

Figure 3. Configuration of the SEM model designed to assess the interplay between digitalisation and public governance. Source: Authors' research in Stata 17.

For the second research hypothesis (H2), we used Gaussian and Mixed-Markov graphical models (GGMs, MGMs) as network models of conditional associations to appraise the positive and negative correlations and interlinkages between digitalisation and public governance considering all dimensions and subdimensions of both digital transformation processes (including infrastructure) and public governance.

From a methodological perspective, a Gaussian graphical model (GGM) for a random vector $X = (X_1, \ldots \ldots, X_p)$ is determined by a graph G on p nodes. "The model comprises all multivariate normal distributions $N(\mu, \theta^{-1})$ whose inverse correlation matrix satisfies that $\theta_{jk} = 0$ when $\{j, k\}$ is not an edge in G" [72]. "The undirected graph $G = (V, E)$ includes a vertex set $V = \{1, \ldots, p\}$ as well as an edge set $E \subset V \times V$" [73]. "Let $\Omega_d = (\omega_{ij,d}) = \Sigma_d^{-1}$ for d = 1,2 be the precision matrix for $X = [x^1, \ldots, x^{n1}]^T \in R^{n1xp}$ and $Y = [y^1, \ldots, y^{n2}]^T \in R^{n2xp}$. X and Y denote the data matrices. The precision matrix (inverse covariance matrix) $\Omega = \Sigma^{-1}$ represents a GGM. A GGM associated with X is a graph; similarly, a GGM associated with Y is also a graph" [73].

The interlinkages are graphically reflected in GGMs and MGMs through the lines/edges that connect the nodes, namely, blue edges for positive connections (partial correlations) and red edges for negative correlations. The intensity of linkages is shown by the absolute strengths (width and saturation) of the edges between the nodes (variables). The lack of an edge between two nodes means that the (partial) correlation is zero, and, therefore, no linkage is identified between those specific nodes (e.g., variables are independent after conditioning on all other variables in the dataset) [72].

Both structural equation and network models have their origin in path analysis and imply a variance–covariance matrix, which was employed in this research to identify and assess the specific ways in which variables are related to each other (direct and indirect effects of one variable on another) and, more specifically, how digitalisation credentials affect public governance.

4. Results and Discussion

Structural equation modelling (SEM) results are presented in Figure 4 and detailed in Appendix A, Table A1. A robustness check was undertaken through a series of specific tests applied (e.g., root mean squared error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI), coefficient of determination (CD), standardised root mean squared residual (SRMR), average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha).

RMSEA reported under the population error dimension of the goodness-of-fit test was 0.045, which suggests a good (close) fit, as also indicated by Browne and Cudeck [74] and Hu and Bentler [75]. CFI and TLI reported under the baseline comparison have values close to 1, thus indicating a good fit (CFI = 0.846, TLI = 0.816). Moreover, under the size of residuals, we reported CD and SRMR. CD = 0.937 and acts like a R^2 for the whole model, where a value very close to 1 indicates a good fit. SRMR = 0.029 and corresponds to a "small" value (limited by some at 0.08), thus indicating that the model also fits well by this standard.

The convergent validity of the measurement model was assessed through the AVE and the composite reliability (CR) (CR tends to be considered to be a less biased estimate of reliability than Cronbach's alpha [76]). Fornell and Larcker [77] and Shrestha [78] suggest that AVE should be greater or equal to 0.5, while Alarcon and Sanchez [76] state that CR should have an acceptable value of 0.7 or above to confirm convergent validity and composite reliability, and thus ensure internal consistency. In our model, AVE = 0.621 and CR = 0.854, evidencing the convergent validity and internal consistency in scale items, namely, a high degree of confidence that the constructs are well measured by their indicators.

The internal consistency was also assessed, using Cronbach's alpha coefficients to test the instrument accuracy and reliability of the data. In general, a value greater than 0.7 indicates a good internal consistency [78]. In Table A2 of Appendix A, all components/items have Cronbach's alpha values greater than 0.9, and the total scale Cronbach's alpha value for the factors with total scale reliability is 0.9455 (>0.7). This shows an excellent internal consistency, that is, the variables exhibit a correlation with their component grouping, with good stability and reliability.

The main results highlight that the digitalisation credentials induce a positive and significant impact on public governance, as considered in this research through the latent variable "Governance" constructed from six subdimensions of WGIs. The estimated coefficient of 0.031 is positive and statistically significant at the 0.1% threshold. The most notable positive inferences tend to be related to the control of corruption, rule of law, and government effectiveness. Hence, agents gain confidence in and abide by the rules of society and the quality of contract enforcement and institutions. Citizens also improve their perceptions when sound digitalisation advancements are accomplished. Moreover, government effectiveness (GE) increases under digital developments, while political stability (PSAV) is slightly (again positively) affected.

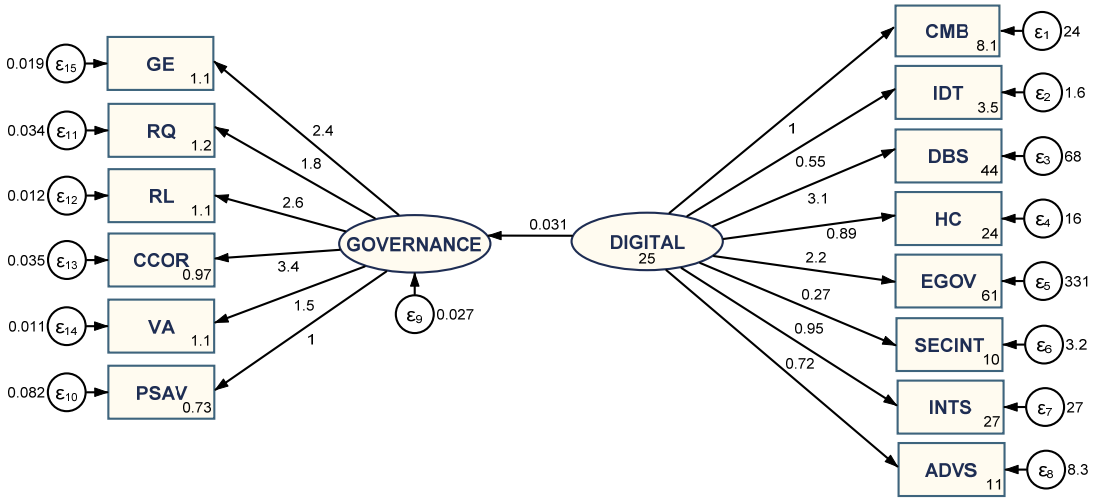

Figure 4. Results of the structural equation modelling (SEM model). Source: Authors' research in Stata 17.

Our results are in line with those obtained by Wandaogo [79], who also identified a positive relationship between digitalisation and government effectiveness; this earlier study used a different method, and applied a panel model with fixed effects, indicating that an increase in digitalisation by one point can generate an increase in government effectiveness by 0.1 points. Moreover, Wandaogo [79] indicated that the political stability and absence of violence and/or terrorism determines government effectiveness. Dhaoui [80] also demonstrated that ICT development has a positive and significant impact on the control of corruption. Therefore, in line with our results, the same positive impact was identified in the case of e-service infrastructure and ICT infrastructure on government effectiveness, and the case of e-service infrastructure on quality regulation, while ICT infrastructure and the human capital index do not have a significant impact on quality regulation. Using a different approach, employing robust path analysis, do Nascimento et al. [81] identified some important results related to the number of people who access the Internet (Internet diffusion) in a country, and its impact on government corruption and voice and accountability, as our results demonstrate.

Therefore, the first research hypothesis, *(H1). There are positive inferences of digital transformation upon public governance at the level of the European Union, is fulfilled*.

To further test the second research hypothesis (H2), we configured and estimated two graphical models, a GGM and MGM, based on the extended Bayesian information criteria and partial correlation methods. The GGM results presented in Figure 5 suggest several *positive linkages*, as follows:

- Between the effectiveness of government (GE) and the human capital (HC) involved in complex activities that engage the use of digital services;
- Between the change in the perceptions of people about the quality of public services (GE) and the decision to use the Internet to actively communicate with public authorities (EGOV);
- Government's abilities to enforce regulations and policies (RG), which can further sustain the achievement of digital skills, at least at a basic level, by the entire society (INTS);
- Better perceptions of the people about the freedom of expression and media (VA) will undoubtedly lead to a positive influence on cellular technology by using telephone services (MOBCELL);
- Moreover, good perceptions and a higher degree of confidence in the rules of law (RL) determine a positive influence on the need for connectivity in digital services, especially the supply side of fixed and mobile broadband (CMB).
- Furthermore, *negative correlations* are also suggested, such as:

- Between the perceptions of citizens about political instability/terrorism (PSAV) and the use of digital public services of the public administration (EGOV);
- A relevant impact of regulatory quality (RQ) on digital connectivity by the broadband infrastructure (CMB) is identified, which is reflected in the public governance representative indicators under the influence of the integration of digital technology, including the digital intensity (IDT).

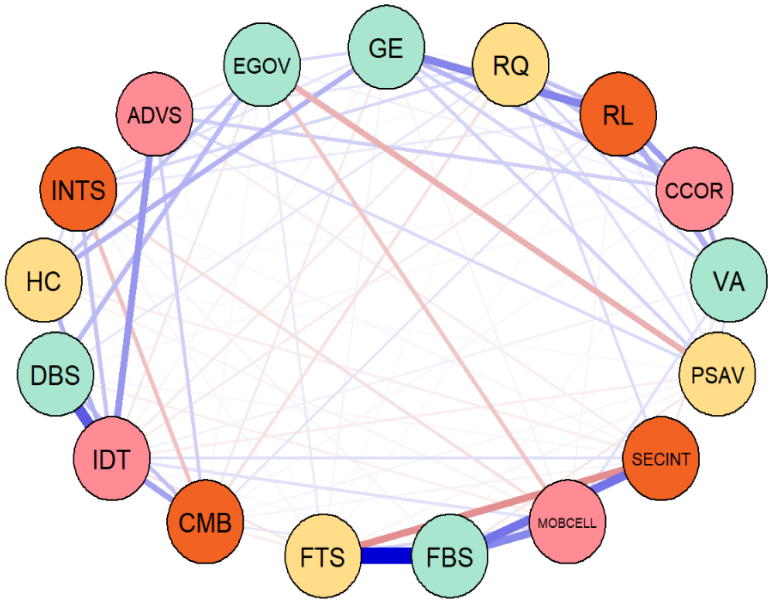

Figure 5. Results of the Gaussian graphical model (GGM). Source: Authors' research in RStudio 4.2.2.

Stronger linkages are captured in the MGM shown in Figure 6. Thus, the linkages between the variables capture the following associations regarding digital transformation and public governance dimensions:

- Positive linkages with government effectiveness (GE) related to e-government users (EGOV), integration of digital technologies (IDT), the demands and supplies of the digital public services using open data (DBS), and the existence of basic skills of the Internet users (INTS), on the one hand, and negative synergies with the broadband connectivity (CMB) and different types of corruption (CCOR), on the other hand;
- A favourable influence on the control of corruption (CCOR) regarding connectivity through mobile broadband (CMB), the Internet servers that are secure (SECINT), and the people with digital skills (among some dimensions, such as communication and information, content creation through different software, safety, and problem solving) (INTS), and unfavourable influences with Internet users that make less use of the activities that involve the use of digital devices, along with other activities on the Internet (HC), and with public services that have integrated the digital technologies (DBS).

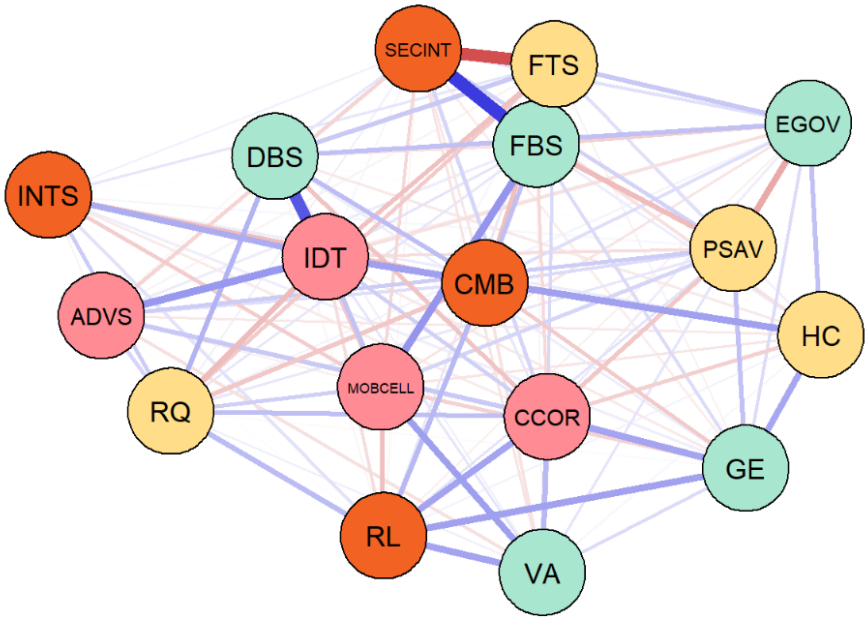

Figure 6. Results of the Mixed-Markov graphical model (MGM). Source: Authors' research in RStudio 4.2.2.

These results align with those obtained by Gulati and Yates [82], who applied multiple regression analysis models; their results indicate a positive relationship between broadband technology and public governance (captured through World Governance Indicators, WGIs). Moreover, their results evidence that an increase of one unit of the governance index generates a 63.7% increase in the number of broadband subscriptions per 100 people. On the contrary, Yates et al. [83] do not find a relationship between broadband coverage and regulatory quality; these results are contrary to the second hypothesis formulated in our research due to the reduced regulation of the development market in the telecommunications industry.

Therefore, the second working hypothesis, *(H2). There are strong interlinkages (both positive and negative) between digitalisation dimensions (including technological/broadband infrastructure) and public governance credentials*, is fulfilled.

Based on these findings, tailored policies and specific strategies regarding the digital transformation of public governance are necessary. These are especially needed in terms of digital public services, Internet user skills, secure Internet servers, and digital connectivity, in order to improve the integration of digital technologies in public digital services and the control of different corruption actions, in addition to the stability of the political frameworks and stable regulations, to increase the credibility of citizens regarding the use of digital technologies in the relationship between citizens and public authorities.

The results revealed that the European Union countries accelerated the rate at which they were adopting digital technology and Internet usage in the context of the COVID-19 pandemic and other unpredictable circumstances, thus also impacting public governance with further spill-over effects at both micro- and macroeconomic levels.

Our estimations indicate that the use of digital tools in the relationship with and interactions between the public decision factor (the government, i.e., regulatory quality, government effectiveness, the reduction in corruption, political stability and confidence in rules of law and citizens' digital skills, use of digital technologies, and digital public services) defines the transformation of good governance in the digital era through digital technology that contributes to the improvement and simplification of various institutional aspects, namely, communication, business, quality services, safety, and welfare of the community as a large. This was also substantiated by Chen et al. [42]. Moreover, the control of corruption can be closely associated with government effectiveness [84], which indicates that the positive influences of these credentials can stimulate the digital transformation of public governance.

According to the SEM, GGM, and MGM results, the digital transformation of public governance can be increased by efficient and proper collaboration between decision makers and all levels of society. Thus, the integration of digital technology provides high-quality services characterised by the ease of exchanging information, faster communication, and unlimited access to technologies, secure and sustainable digital infrastructures, security, and connectivity. This is in line with the results obtained by Ludlow and Khan [43]. However, with digital transformation, many obstacles and limitations have arisen, especially the requirement to improve the quality of resources, the need for innovative services, and the technical disparities and policy conflicts that lead to specific ambiguities related to the application of standard operating procedures [43,85]. Further, governments should adopt information technology in many areas to increase living standards and boost society's evolution [86].

5. Conclusions

Against the background of the increasing global significance of technology investment and development in the public sector, this research study provides an overview of the implications of digitalisation on public sector governance, given the notable differences among European Union Member States, and under consideration of their interlinkages with technological/broadband infrastructure. In this study, we empirically assessed the relationship between digital transformation and public governance, with a detailed analysis of the EU-27 Member States, considering the historical data for 2010–2021. The research endeavour focused on testing two hypotheses by applying two advanced econometric techniques, namely, structural equation modelling (SEM), in order to analyse the interlinkages (direct, indirect, total) between the digital transformation credentials and public governance (captured through World Governance Indicators), and Gaussian graphical models (GGM and MGM), designed to account for the interdependencies between all considered variables (including technological/broadband infrastructure representative variables).

Therefore, the main findings that were revealed following the two research hypotheses, by considering the EU-27 Member States, highlighted that: (i) an increase in the digital transformation level led to significant improvements in public governance captured through all six World Governance Indicators; all of the Digital Economy and Society Index (DESI) indicators had a similar positive impact on the World Governance Indicators, by determining an increase in the government effectiveness, strengthening the rule of law framework, and providing a more restrictive regulatory quality, while maintaining a low level of corruption; and (ii) there is a notable contribution of technological progress to the advancement in the field of digitalisation of public governance in certain EU countries. The results are consistent with other research from the existing literature [42,79,82].

Consequently, the main contributions of our research provide new empirical evidence to support an overall vision of the impact of digital transformation on public governance across the European Union, and the risks and opportunities around EU digital governance, as countries are constantly concerned with sound digitalisation frameworks and quality infrastructure in public governance. The digital transformation of public governance can be highlighted by efficient and proper collaboration between decision makers and all levels of society; thus, the integration of digital technology provides high-quality services characterised by the ease of exchanging information, faster communication and unlimited access to technologies, and secure and sustainable digital infrastructures, security, and connectivity [87].

Based on the obtained results, a series of recommendations can be made regarding the interplay between public governance and digital transformation. First, sound institutional frameworks, which need to be designed and well-oriented public policies, should be implemented at the level of EU-27 MSs to enhance the capacity to address the digitalisation process of public governance. Second, it is necessary to promote the integration of digital technology in order to increase the quality of public governance, to sustain a high level of innovation and economic development, and to enhance public sector productivity. This

should be undertaken by encouraging the government of each country to further embrace the digital evolution of public governance to transform how the public sector tackles social and economic challenges. In addition, governments can consider increasing the degree of transparency in the public sector and integrating digital technology in public governance as a measure to reduce corruption, thus encouraging and facilitating the active participation of citizens in the decision-making process.

In addition, the main implications of our findings highlight that the digital transformation of public governance can be boosted by improvements in the design of targeted policies and specific strategies related to digital technology integration. This will increase the credibility of citizens regarding the use and integration of digital tools that can decisively boost the quality of public governance, the creation of well-supported measures, and public government support for the improvement in digital transformation of public governance, especially for developing countries, thus ensuring the specific framework that can be implemented for all of the EU-27 MSs.

The research has limitations resulting from the relatively poor availability of data for specific indicators required to capture the amplitude and complexity of digitalisation processes. Future research will consider a separate analysis of subpanels of EU Member States to enhance tailored impacts, dissimilarities, and distinctive features of the interplay between digitalisation and public governance.

Author Contributions: Conceptualization A.-M.Ț., R.-I.R. and A.-F.C.; methodology, G.G.N., M.G.P. and R.-I.R.; software, G.G.N., A.-F.C. and A.-M.Ț.; validation, M.G.P. and G.G.N.; formal analysis, A.-F.C. and R.-I.R.; investigation, R.-I.R., A.-M.Ț. and A.-F.C.; resources, M.G.P. and R.-I.R.; data curation, A.-M.Ț., M.G.P. and G.G.N.; writing—original draft preparation, A.-F.C., A.-M.Ț. and G.G.N.; writing—review and editing, G.G.N., A.-M.Ț. and M.G.P. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Detailed SEM results, maximum likelihood method (with missing values).

Variables	Coefficients
	/SE
GOVERNANCE	
DIGITAL	0.0311 ***
	(0.00369)
CMB	
DIGITAL	1
	(.)
_cons	8.116 ***
	(0.407)
IDT	
DIGITAL	0.550 ***
	(0.0362)
_cons	3.521 ***
	(0.175)

Table A1. *Cont.*

Variables	Coefficients
DBS	
DIGITAL	3.139 ***
	(0.214)
_cons	44.21 ***
	(1.026)
HC	
DIGITAL	0.888 ***
	(0.0745)
_cons	23.81 ***
	(0.345)
EGOV	
DIGITAL	2.229 ***
	(0.264)
_cons	60.75 ***
	(1.237)
SECINT	
DIGITAL	0.266 ***
	(0.0264)
_cons	10.12 ***
	(0.129)
INTS	
DIGITAL	0.951 ***
	(0.0883)
_cons	26.92 ***
	(0.407)
ADVS	
DIGITAL	0.721 ***
	(0.0562)
_cons	11.35 ***
	(0.267)
PSAV	
GOVERNANCE	1
	(.)
_cons	0.731 ***
	(0.0211)
RQ	
GOVERNANCE	1.825 ***
	(0.144)
_cons	1.167 ***
	(0.0262)
RL	
GOVERNANCE	2.627 ***
	(0.197)
_cons	1.103 ***
	(0.0349)

Table A1. *Cont.*

Variables	Coefficients
CCOR	
GOVERNANCE	3.397 ***
	(0.257)
_cons	0.975 ***
	(0.0457)
VA	
GOVERNANCE	1.489 ***
	(0.114)
_cons	1.079 ***
	(0.0204)
GE	
GOVERNANCE	2.409 ***
	(0.183)
_cons	1.092 ***
	(0.0325)
/	
var(e.CMB)	24.47 ***
	(2.202)
var(e.IDT)	1.602 ***
	(0.219)
var(e.DBS)	68.14 ***
	(7.695)
var(e.HC)	15.72 ***
	(1.478)
var(e.EGOV)	331.1 ***
	(28.21)
var(e.SECINT)	3.215 ***
	(0.280)
var(e.INT)	26.74 ***
	(2.406)
var(e.ADVS)	8.295 ***
	(0.777)
var(e.MOBCELL)	0.0820 ***
	(0.00678)
var(e.RQ)	0.0343 ***
	(0.00301)
var(e.RL)	0.0121 ***
	(0.00163)
var(e.CCOR)	0.0345 ***
	(0.00371)
var(e.VA)	0.0109 ***
	(0.00104)
var(e.GE)	0.0195 ***
	(0.00200)
var(e.GOVERNANCE)	0.0267 ***
	(0.00471)
var(DIGITAL)	24.85 ***
	(3.628)

Note: "Standard errors in parentheses, *** $p < 0.001$". Source: Authors' research in Stata 17.

Table A2. Cronbach's alpha for the SEM model, EU-27, 2010–2021.

Test Scale = Mean (Standardized Items)				
Average			**EU-27**	
Item	**Obs**	**Sign**	**Inter-Item Correlation**	**Alpha**
CMB	324	+	0.5747	0.9461
IDT	324	+	0.5528	0.9414
DBS	324	+	0.5524	0.9413
HC	324	+	0.5444	0.9395
EGOV	324	+	0.5730	0.9458
SECINT	297	+	0.5915	0.9496
INTS	324	+	0.5495	0.9407
ADVS	324	+	0.5461	0.9399
PSAV	324	+	0.5767	0.9466
RQ	324	+	0.5412	0.9388
RL	324	+	0.5351	0.9374
CCOR	324	+	0.5351	0.9373
VA	324	+	0.5378	0.9380
GE	324	+	0.5359	0.9375
Total scale				0.9455

Source: Authors' research in Stata 17.

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